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ABSTRACT

Value Engineering (VE) is a cost optimizing technique used to analyze design quality and cost-effectiveness. The application of VE procedures to the design and construction of school facilities has been adopted by the state of Washington. By using VE, the optimum value for every life cycle dollar spent on a facility is obtained by identifying not only initial costs but also operations, maintenance, and replacement costs. This paper outlines the contents of a manual to be prepared that would assist school districts to implement VE procedures in specific school facilities projects. VE is required for projects with a capital expenditure greater than $1 million in construction costs; its use is optimal on lower cost projects. A VE program requires four participants: the Superintendent of Public Instruction, the school district, the design architect/engineer consultant, and the VE consultant. Their tasks and compensation are discussed. The information required for VE analysis are also listed, including, in general, program design requirements and criteria, the site plan, floor plans and other drawings, descriptions of building systems, an outline of materials specifications, and a cost estimate. The paper closes with a list of possible conflict areas, a glossary of VE terms, and a bibliography. (MLF)

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VALUE ENGINEERING

"A working tool for cost control in the design of educational facilities"

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American Institute of Architects
Committee on Architecture for Education

February 14, 1981

AASA Convention
Atlanta, Georgia

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Value engineering (VE) is a creative, organized, cost optimizing technique used to analyze a design. The optimum value for every life-cycle dollar spent on the facility is obtained by identifying not only initial costs but also operations, maintenance and replacement costs. The primary optimization method is the use of the functional analysis techniques presented in the VE job plan.

HISTORY

Value engineering was one of the cost reduction techniques developed of necessity during World War II. General Electric Company realized the substitution of lower-cost materials and alternative designs could, in fact, be intentionally formalized to improve product efficiency. Private industry was responsible for initial development of programs for "value improvement," "value control," "value management," and "value analysis." The Department of Defense Navy Bureau of Ships was the first U.S. Government agency to implement a formal program, which was formally named "value engineering" to emphasize the Bureau's engineering priorities.

Many of these early programs dealt primarily with value engineering of manufactured hardware. The adoption by the Department of Defense of VE procedures throughout the agency in 1961, program development between 1963 and 1965 through staffing with full-time VE engineers and use of incentive clauses in construction contracts, changed the focus to analysis of facilities design and construction techniques. Since the mid-1960's, most of the major Government agencies, the National Academy of Sciences' Federal Construction Council Building Research Advisory Board and the Pacific Northwest Bell Company, have studied the benefits of value engineering. Most have adopted the program.

The 1977 first extraordinary session of the Washington State Legislature established the Washington School Facilities Cost Stabilization Program within the Office of the State Superintendent of Public Instruction. The goals of the program are:

1) To stabilize school construction, maintenance and operating costs.

2) To reduce school design/construction time.

3) To provide high-quality schools capable of being readily and economically adapted to changing school and community needs.

The Washington School Facilities Cost Stabilization Program has been charged with the task of investigating and/or experimenting with emerging design/construction and maintenance/operation practices and of assisting school districts in implementing those which hold promise of achieving one or more of the program goals identified above.

The purpose of developing a Value Engineering Procedures Manual is to provide procedural and technical guidelines for conducting value engineering (VE) studies for school facilities construction projects in the State of Washington. The application of value engineering procedures to the design and construction of school facilities has been accepted by the Office of the Superintendent of Public Instruction (SPI) of the State of Washington as an effective means to implement the Washington School Facilities Cost Stabilization Program.

The VE Procedures Manual would be prepared to provide guidance to the school district, the design architect/engineer (A/E) and the VE consultant in the use of VE procedures. The goals of the manual are to provide guidance in:

1) Developing the scope and applicability of VE to school projects.

2) Establishing standards of quality for VE studies.

3) Defining the level of effort required for successful VE studies.

Value engineering has been singled out by the School Facilities Cost Stabilization Program Advisory Board as one of the emerging design/construction

practices that merits further study. The results of the prototype VE project as well as others indicate that value engineering does have the potential to achieve the goals of the School Facilities Cost Stabilization Program. The purpose of this manual is to assist school districts in implementing value engineering procedures on specific school facilities projects.

VALUE ENGINEERING PROGRAM GOALS

Given that value engineering is a creative, organized, analytical approach to design review whose objectives are to optimize the total cost and/or performance of a facility, it is being applied by the SPI as a means to develop a systematic approach to the analysis of school facilities design. If a school construction, addition or modernization project is considered in its entirety, four major groups of decision-makers affect the total cost of the facility: the school district/school board; the architect/engineer; the contractor; and the operations and maintenance staff. As shown on Figure 101, of these four groups, the school district, standards and criteria, and the design A/E have the greatest impact on the cost of the facility. The A/E's decisions regarding structural design elements, equipment and materials selection directly affect both capital and operation costs in the short term, and replacement or modification costs in the long term.

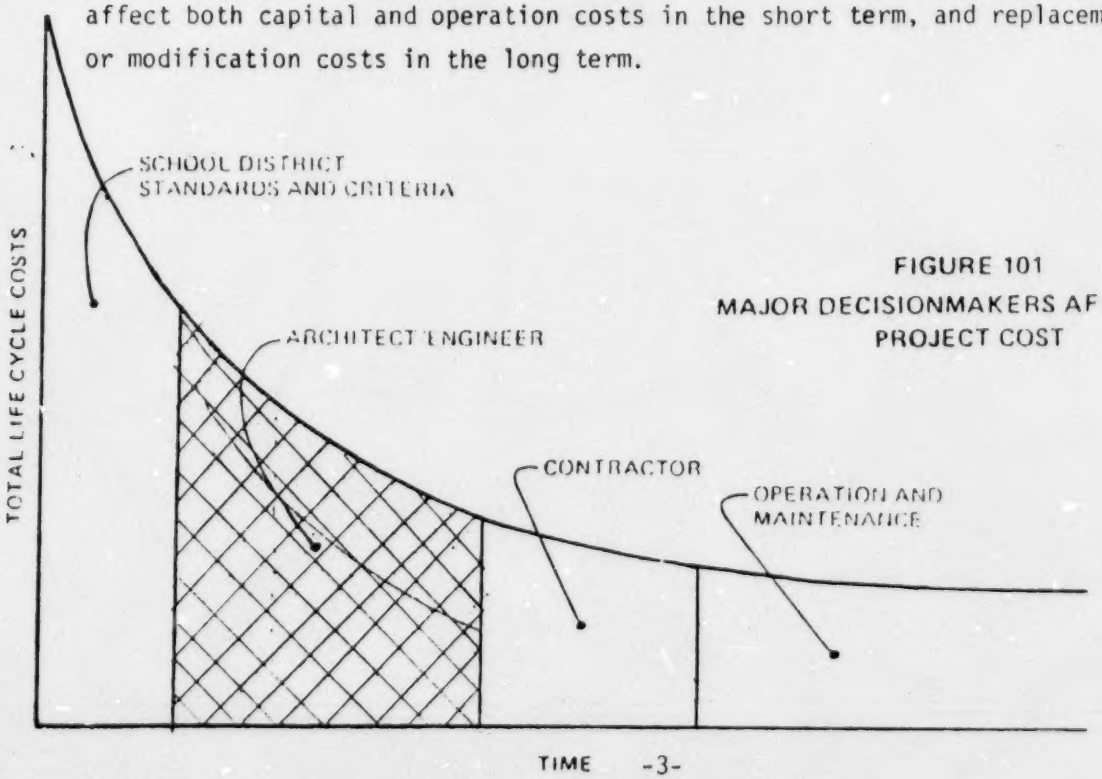


FIGURE 101
MAJOR DECISIONMAKERS AFFECTING
PROJECT COST

The local school districts can most appropriately expect to optimize costs by concentrating on the design phase of a project, assuming that construction costs are minimized by appropriate application of the design.

The goals of the value engineering program are as follows:

1) To eliminate or modify any aspect of a school facilities design which increases the facility's costs without contributing directly to its functional aspects.

2) To evaluate the construction, maintenance, operation and replacement costs of school facilities designs through a functional approach to life-cycle costing.

3) To develop alternative design concepts for school facilities, where appropriate, that reduce life-cycle costs and still meet the educational specifications of the school district and comply with the rules and regulations of the State Board of Education.

QUALIFYING PROJECTS

Since school projects with a capital expenditure greater than $1 million in construction costs can benefit most from the use of the value engineering techniques defined in this paper, the SPI suggests school districts use value engineering on projects of this size. The use of VE is optional on projects with construction costs under $1 million; these projects should be considered on a case-by-case basis.

PARTICIPANTS

The VE program involves four participants: the Superintendent of Public Instruction, the school district, the design A/E consultant and the VE consultant.

A) The Superintendent of Public Instruction (SPI):

The staff of the Superintendent of Public Instruction will provide direction to the school district in the use of value engineering procedures, work with the school district in selecting a VE consultant, and act as a liaison to facilitate communication between the school district and the VE team(s), review VE project reports, assist school districts in preparing proposals, and assist in paying for design A/E and VE consultant fees.

B) The School District:

The school district will select an appropriate value engineering consultant; complete the B-Form and VE-Form processes; negotiate the VE contract; answer the VE team(s) questions; and pay the design A/E's and VE team(s') fees for VE involvement.

C) The Design Architect/Engineer (A/E):

The design A/E will brief the VE team(s) on the design criteria and concepts used in the design; supply drawings, specifications, cost estimates, and other documents to the VE team(s) to orient them to the design elements and functions; review and respond to the VE proposals; and estimate the cost of redesign based on the accepted VE proposals.

D) The VE Consultant:

The value engineering consultant will organize and manage the VE team(s); coordinate communications between the design A/E, the school district and the VE team(s); prepare the report of the VE study; and summarize the results of the VE study to the designer and the school district in both an oral and written presentation. The VE consultant will ensure that the standard value engineering methodologies approved by the Society of American Value Engineers (SAVE) are followed throughout the study.

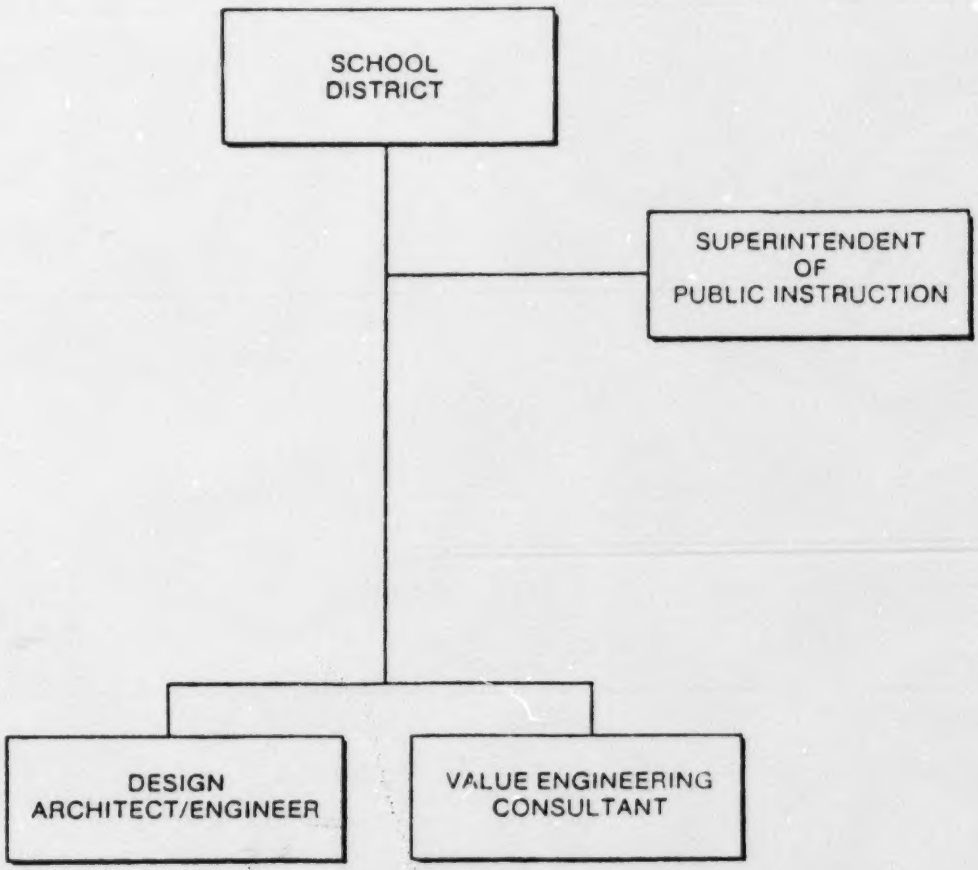


FIGURE 202

GENERALIZED VE PROJECT ORGANIZATION
FOR SCHOOL FACILITIES

SUPERINTENDENT OF PUBLIC INSTRUCTION
VE PROCEDURES MANUAL

VE CONSULTANT SELECTION

The value engineering consultant must be selected early in the design process, shortly after the design A/E is retained and the scope of the project is defined. The VE consultant selection process should be similar to that used for selecting the design team.

Care in VE consultant selection will ensure adequate VE project performance, especially if the VE consultant offers appropriately qualified design professionals to assist on the VE team.

RECOMMENDED FEE ARRANGEMENTS

Fee negotiations for the value engineer should either be negotiated on a lump sum or cost-plus-fixed-fee basis. No contingency contracts should be accepted--both to avoid potential conflicts of interest and to comply with the codes of ethics for architects and engineers.

VE TEAM MEMBERS

Since the technical qualifications of the VE team members directly affect the quality of the VE analysis, the size and makeup of VE study team(s) should be discussed with the value engineering consultant during the selection process. For a value engineering study to be most effective, the study team(s) must include individuals with design experience in several design specializations (disciplines). A VE analysis of a school project requires the following design professionals: an architect; a structural engineer; a heating, ventilating and air-conditioning engineer; an electrical engineer; and a building maintenance specialist. In special cases, other disciplines may be required, such as a geotechnical or general civil engineer, or an estimator.

A team should be limited to five or six people, depending on the complexity of the project. The sixth person could be an educational facilities planner or

an educator from the school district, but should not be someone who was directly involved in the planning of the project being analyzed. It is highly recommended that a school district representative participate on the study team so the district will gain a better understanding of the VE process.

LEVEL OF EFFORT

The number of VE teams required for the value engineering project is determined by the size of the project and the results desired by the district as shown in Table 201.

Table 201
Estimated VE Team Effort

Level of Effort	Capital Cost of Projects
No VE team	Less than $500,000
Case-by-Case basis	$500,000 - $1 million
At least one VE team	$1 - $5 million.....most school facility projects
One team, possibly two	$5 - $10 million
Two teams, possibly three	$10 - $20 million
Case-by-Case basis	Greater than $20 million

Similarly, a straight line drawn on the nomograph shown on Figure 203 will also correlate the number of VE teams normally required for a VE study, based on the size, complexity and construction cost of the design project.

COMPENSATION

The design A/E is eligible for a payment proportionate to the number of VE teams used on the project. Participation by the design A/E should be paid for as "extra services," as defined in Article III of the Standard

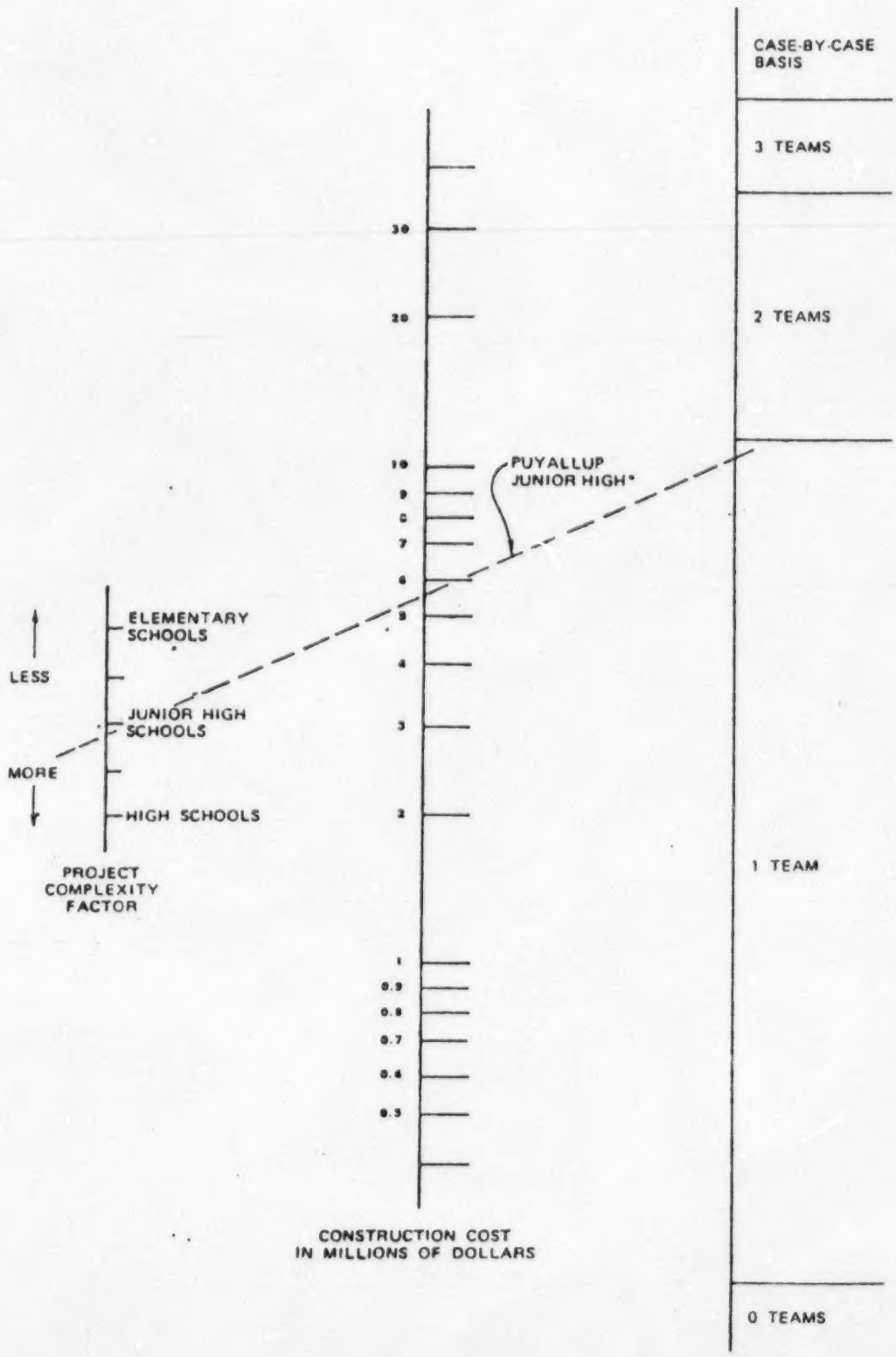


FIGURE 203

LEVEL OF VE EFFORT NOMOGRAPH

SUPERINTENDENT OF PUBLIC INSTRUCTION

*--ESTIMATED LEVEL OF EFFORT FOR PROTOTYPE VE STUDY

Architectural Agreement, and should be so stated in the contract executed between the district and the design A/E.

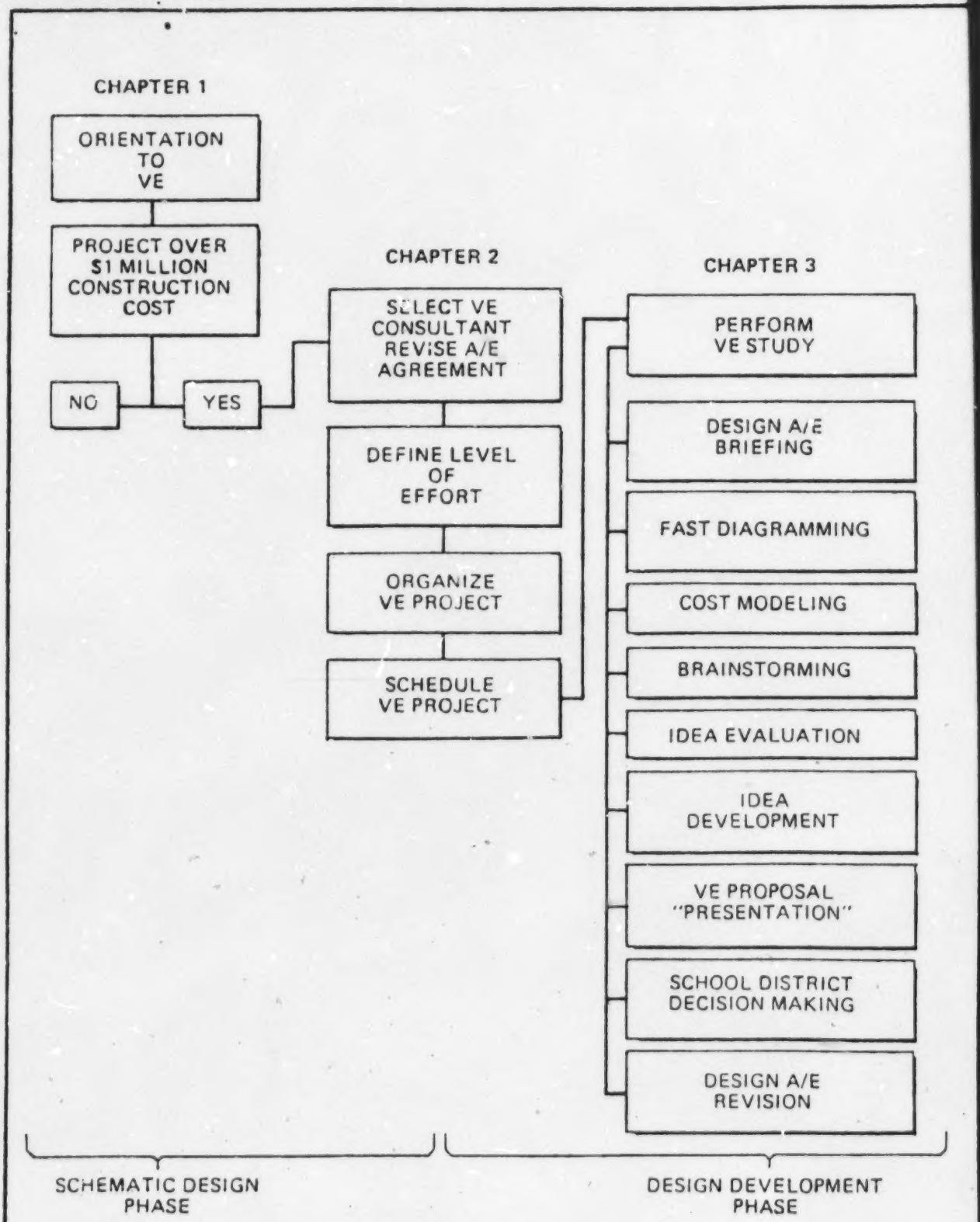
The VE-Forms will be used to account for the impact of value engineering on the design A/E's time requirements and fees and should cover the architect's cost in briefing the VE team(s) and responding to the VE team(s') questions and proposals. Similarly, the design A/E should be compensated for redesign time, based on the A/E's statement of the lump sum cost that will be adequate to perform the redesign for each accepted VE proposal. Given this data, the school district and the SPI will then be able to evaluate the VE proposal, after subtracting the redesign cost. This scheme also overcomes the problem of a disincentive fee structure that could inhibit a design A/E from implementing an energy conservation proposal.

DESIGN A/E FEE ARRANGEMENTS

The school district needs to know from the very outset of negotiations with their selected design A/E whether they will be using value engineering on the facility design. This will enable both parties to scope the project appropriately and include enough staff time in the design A/E's fees.

TIMING OF VE ANALYSIS

The timing of VE analysis is critical to the success of the value engineering effort. If done prematurely, the design A/E may not have sufficiently developed the design, thus making the alternative analysis ineffective. Completed too late in the design, redesign costs can negate the VE proposal's savings. Therefore, it is important to define a point in the design, as a stage at which to begin the VE analysis, on a case-by-case basis during VE contract negotiations. Regardless of the size of the VE project, data contained in the preliminary design must be available to the VE consultant before value engineering preparation can begin effectively.



NOTE:

CHAPTER 4 IS THE FINAL REPORT OF A VE CONSULTANT OF THE VE ANALYSIS PERFORMED FOR PUYALLUP SCHOOL DISTRICT.

FIGURE 102

SCHOOL DISTRICT VE PROCEDURES AS SHOWN IN THIS MANUAL

SUPERINTENDENT OF PUBLIC INSTRUCTION VE PROCEDURES MANUAL

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For smaller projects only one VE analysis is required. To maximize savings, the workshop should be conducted after completion of the preliminary design phase, when the design is 25 to 30-percent complete.

Should two teams be required, they should be scheduled at the 10 to 15-percent and about the 25 to 30-percent design completion point. As a general rule, no teams should be scheduled once the design is 45 to 50-percent complete.

Since the design cannot be finalized until a decision is made on the VE proposals, the process must be timely.

SUBMITTALS REQUIRED FOR VE ANALYSIS

To effectively analyze the project for cost savings, the value engineering consultant will need several items of information. Most of these are available only after the project is well defined and many design decisions have been made, but before preparation of working drawings has begun. Usually this occurs in the design development phase.

Generally the pertinent data needed are: program design requirements and criteria, the site plan, floor plans and other drawings, descriptions of building systems, outline specifications and a cost estimate.

SUBMITTALS REQUIRED FOR VE ANALYSIS

- Educational specifications and/or building program.
- Design criteria--Number of students, number of faculty and other staff, number of buses serving facility, floor area summary, design temperature, etc.
- Map of area served indicating site location, other schools and public facilities in the area, land use, zoning, major utilities.
- Geotechnical report of soils conditions.

- Building code analysis.
- Square foot area analysis worksheet.
- Description of foundation and structural framing systems.
- Description of heating, ventilation and air-conditioning systems.
- Project energy evaluation sheet indicating project energy consumption analysis.
- Orientation and climatic analysis.
- Site plan indicating general location and nature of site improvements, buildings, landscaping, easements, future expansion, existing facilities, surrounding streets, utilities and site contour lines.
- Architectural floor plan--Minimum scale 1/8" = 1'0"--indicating exterior dimensions, room layouts, fixed equipment, typical furniture layouts, typical bay spacing and work included.
- Exterior evaluations indicating building exterior appearances, wall materials, windows and sun control.
- Building sections indicating ceiling heights, structural systems and any changes in floor level; e.g., mezzanine, etc.
- Structural floor plan indicating structural framing system and type of foundation.
- Typical wall sections showing wall, floor and roof construction.
- Mechanical floor plan indicating plumbing, heating, ventilation, air conditioning and fire protection systems.
- Electrical floor plan indicating lighting layout.
- Outline specifications for materials, including casework and countertops, plumbing fixtures, luminaires, HVAC and other equipment.
- Cost estimate.
- Any unique information regarding the project.

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Possible Conflict Areas:

- VE team only responding to cost-saving reductions while not addressing educational program needs or aesthetic considerations.
- Possibility of embarrassment to architect/engineering team as to design of facility.
- Possibility of embarrassment to client (school district) as to their "wants far beyond their means" and inability to control program decision-makers.
- A negative VE approach can destroy a positive A/E-owner relationship based on professional respect.
- Difficulty of selling VE process as an extra service.

VALUE ENGINEERING IS NOT:

- Value engineering is NOT providing additional detailed cost estimates.
- Value engineering is NOT having a pre-selected contractor to provide cost guarantees.
- Value engineering is NOT just cheapening a project to save dollars or recommending cost reductions without a total understanding of goals and objectives of project.
- Value engineering is NOT just life-cycle cost analysis for mechanical systems.

AMERICAN INSTITUTE OF ARCHITECTS
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GLOSSARY OF VALUE ENGINEERING TERMS

Certified Value Specialist: A person who is registered by the Society of American Value Engineers (SAVE) after having successfully completed a comprehensive 8-hour examination, demonstrated acceptable proficiency in the performance of VE workshops, and completed an acceptable technical paper on value engineering.

Design Architect/Engineer (A/E): The architectural/engineering firm retained by contract with a school district to design a specific new school facility, addition or modernization project.

Design Team: The project team assigned by the design A/E to complete a school facilities project design, usually involving a project design manager and appropriate members of other design specializations (disciplines such as structural, electrical and mechanical).

Basic Function: This concept is critical to value engineering because it defines the functions a facility and its components must perform. A function is always described as a verb and a noun, thus encouraging a pragmatic thought process. For example, a school cafeteria's "basic function" might be to "feed people."

Life-Cycle Cost: The total cost to the owner for the entire functional life of the project, including all design, construction, operation, maintenance and replacement costs.

Multi-discipline: Both the VE team and the design team should be staffed in a multi-discipline manner; that is, people with varied engineering or other technical specializations would form these teams. For example, appropriate team staffing would include an architect and mechanical, structural, electrical and civil engineer.

Society of American Value Engineers (SAVE): The professional society for value engineering, founded in 1959, with chapters across the U.S.

Review Board: A meeting of appropriate decision-makers having direct responsibility for the performance of a school facility design, for the purpose of deciding whether the design alternatives proposed by the VE team should be incorporated into the final design. This meeting would normally include voting representatives from the school district and the design A/E; other people could attend as nonvoting observers.

Value Engineering (VE): A cost optimization technique involving a systematic, creative analysis of the functions of a project or facility, which limits life-cycle costs by identifying initial, operations, maintenance and replacement costs. Functional analysis techniques are used as the primary cost optimization method.

VE Team Coordinator (VETC): A person qualified by the Society of American Value Engineers to manage and coordinate a VE study. The background requirements generally include 40 hours of an ACEC or AIA-approved workshop and leadership of at least two VE teams. The VETC must be especially sensitive to the interacting needs of the designer, the school district and the VE team members during a study to ensure objective VE analysis.

VE Team Leader: A person qualified by attendance at an accredited 40-hour workshop training program to lead a VE team through all phases of a VE analysis project. The team leader should have participated in at least two VE analyses.

VE Study or VE Workshop: A project study or review session where the objective is to analyze an actual project to propose cost-saving alternatives to the designer. The workshop is performed by a VE team or teams chaired by a VE team leader. Each team session may take 40 hours or less depending on the size and the complexity of the project. Sometimes, a review session may be divided into two or three subsessions of eight to 24 hours each.

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